

## Bird mortality by vehicles

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### Introduction

Highways are an indispensable part of socioeconomic development (Coelho *et al.*, 2005) but they can have negative impacts on natural habitats (Granizo *et al.*, 2002). One impact is habitat fragmentation, which produces a barrier effect, which can divide populations and lead to extinctions of subpopulations (Arroyave *et al.*, 2006), and a border effect, which includes changes in temperature, humidity, radiation, and wind that penetrates the ecosystem up to 50 m from the roadway (Arroyave *et al.*, 2006), resulting in a change in species distribution and abundance. A more direct and visible impact is that vehicles traveling on these highways can kill animals, with the frequency and velocity of vehicles representing the primary factors affecting population size and animal behavior (Taylor & Goldingay, 2004).

Santa Cruz Island is the tourism and economic center of Galapagos. It is an island where transportation plays an important role in day-to-day life and also affects the fauna of the island. Construction of the highway that crosses the island north-south (connecting Puerto Ayora and the Itabaca Canal) began in 1972 (Loza, 1981), was completed in 1974 (Carvajal, 1980), and finally paved in 2000 (Tanner & Perry, 2005). Meanwhile, the number of vehicles in Santa Cruz has increased from 28 in 1980 (Márquez, 2000) to 1276 in 2006 (Villa, 2007).

A total of 177 bird species have been registered in Galapagos (CDF, 2008), including 56 endemic or native species (Jiménez-Uzcátegui *et al.*, 2007). Of this group, 23 are on the Red List (IUCN, 2007) due to their low population numbers (two endemic species have fewer than 150 individuals) and to anthropogenic problems (Wiedenfeld & Jiménez-Uzcátegui, 2008).

In Santa Cruz there are 37 bird species, 20 of which are affected by vehicles according to studies conducted by the Charles Darwin Foundation (CDF; Table 1).



Table 1. Species hit by vehicles recorded by year of study.

Common Name	Scientific Name	1980	2000	2001	2003	2004	2005	2006
Yellow warbler	<i>Dendroica petechia aureola</i>	x	x	x	x	x	x	x
Cuckoo	<i>Coccyzus melacoryphus</i>		x	x	x	x	x	x
Mockingbird	<i>Minus parvulus</i>	x		x	x	x	x	x
Paint-billed crake	<i>Neocrex erythrops</i>			x	x	x	x	x
Smooth-billed ani**	<i>Crotophaga ani</i>		x	x	x	x	x	x
Cattle egret**	<i>Bubulcus ibis</i>		x	x				x
Yellow-crowned night heron	<i>Nyctanassa violacea pauper</i>		x	x	x		x	
Barn owl	<i>Tyto alba punctatissima</i>		x		x	x	x	
Short-eared owl	<i>Asio flammeus galapagoensis</i>		x	x	x			x
Vermilion flycatcher	<i>Pyrocephalus rubinus</i>			x				
Galapagos dove	<i>Zenaida galapagoensis</i>		x	x			x	x
Large-billed flycatcher	<i>Myiarchus magnirostris</i>	x	x	x	x	x	x	x
Woodpecker finch	<i>Camarhynchus pallida</i>			x			x	x
Warbler finch	<i>Certhidea olivacea</i>			x				
Small tree finch	<i>Camarhynchus parvulus</i>		x	x	x	x	x	x
Cactus finch	<i>Geospiza scandens</i>			x	x			
Large ground finch	<i>Geospiza magnirostris</i>	x	x	x	x	x		x
Medium ground finch	<i>Geospiza fortis</i>	x	x	x	x	x	x	x
Small ground finch	<i>Geospiza fuliginosa</i>	x	x	x	x	x	x	x
Vegetarian finch	<i>Platypiza crassirostris</i>	x	x		x			
Unidentified finch*					x	x	x	x
<b>Total number of affected species</b>		<b>7</b>	<b>14</b>	<b>18</b>	<b>15*</b>	<b>11*</b>	<b>13*</b>	<b>14*</b>

\* The unidentified finches are not considered a separate species.

\*\* Introduced species.

Sources: Carvajal, 1980; Márquez, 2000; Llerena *et al.*, 2001; Betancourt *et al.* 2004; Jiménez-Uzcátegui & Betancourt, 2005, 2006, 2007.

These studies reveal a significant increase in the average number of birds killed per km surveyed, from 0.43 in 1980 to 0.70 in 2004 (Jiménez-Uzcátegui & Betancourt, 2004). This increase is due to highway improvements, an increase in the number of vehicles, and the velocity of those vehicles. A slight decrease was registered between 2004 and 2006 (not

statistically significant), which could possibly be due to increased speed controls (Figure 1).

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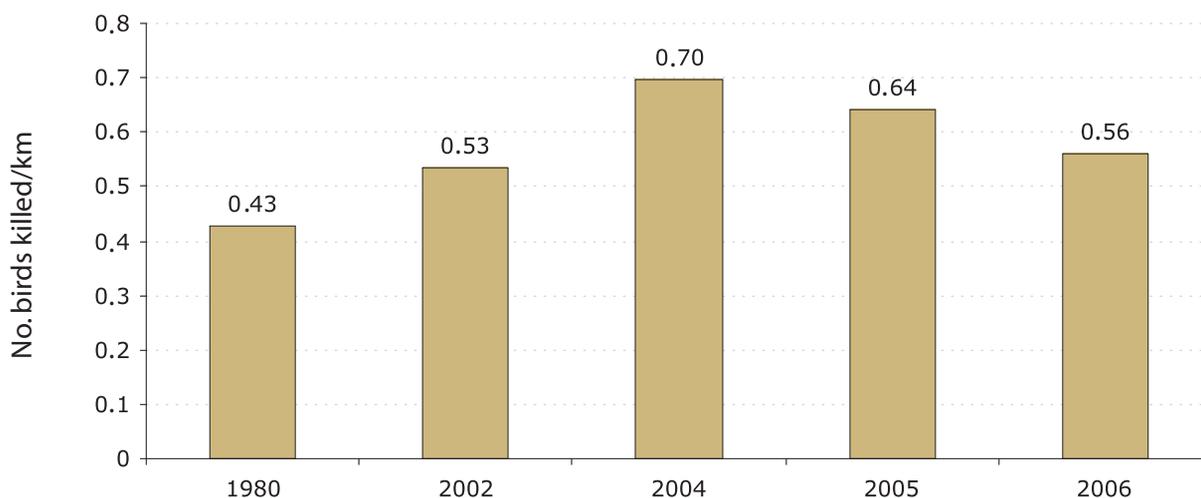


Figure 1. Average number of birds killed on the highway per km surveyed.

In 1980, the small ground finch was the species most affected (Carvajal, 1980). However, between 2004 and 2006, the

yellow warbler was the most affected followed by two species of finch (Figure 2).

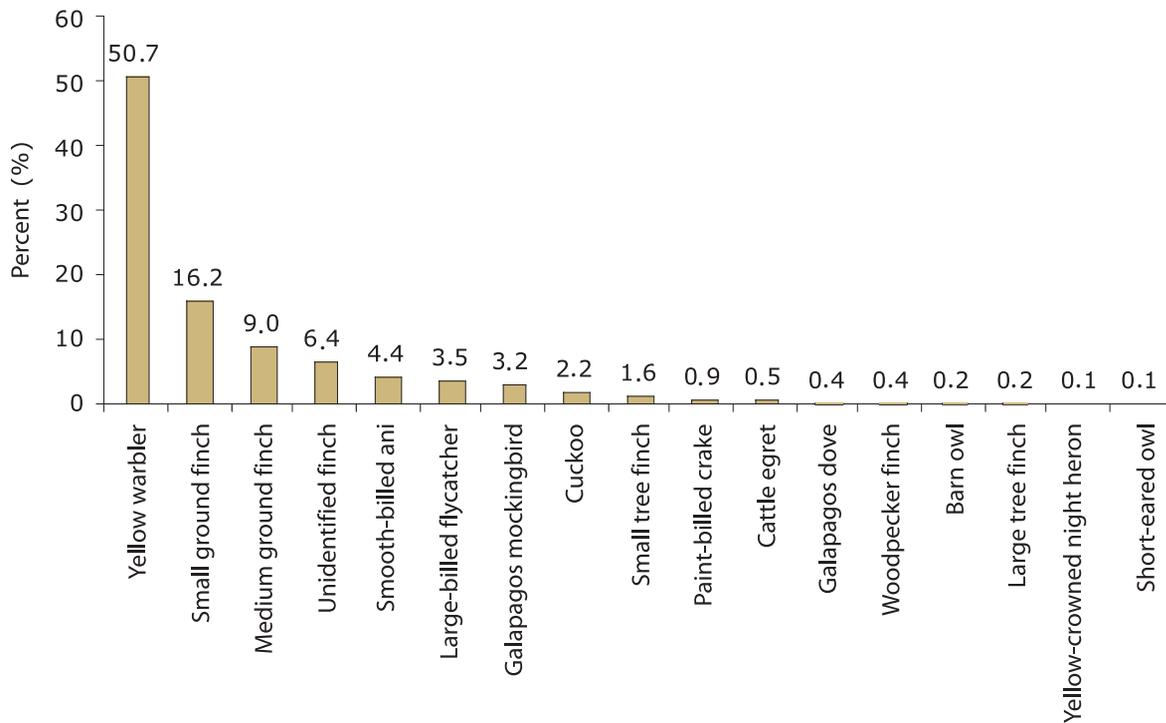


Figure 2. Percentage mortality by species along the Puerto Ayora-Itabaca Canal highway (2004 to 2006).

From 2004 to 2006, a total of 824 dead birds were collected in 33 days of monitoring (one day per month during each year), representing an average of 25 birds per day (the highway was cleaned of dead birds on the day prior to monitoring). The methodology was based on Llerena *et al.*, 2001. Based on these data, it is estimated that from 2004 to 2006, 9000 birds were killed on the highway and that each vehicle

on Santa Cruz killed an average of seven birds per year. A greater number of dead birds were found during the hot season (January to June) (Figure 3).

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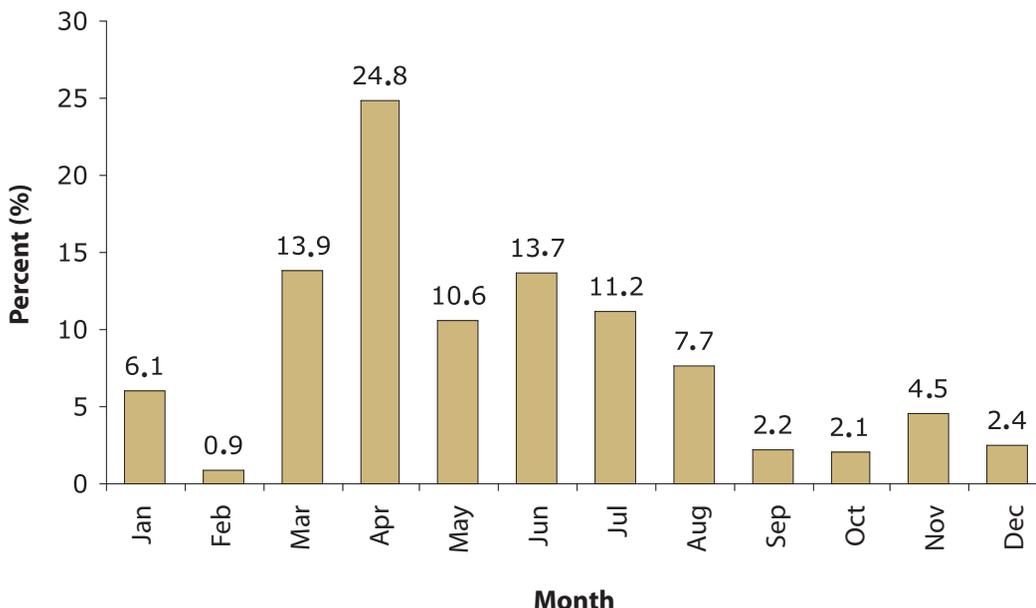


Figure 3. Percentage of dead birds on the Puerto Ayora-Itabaca Canal highway by month (2004 to 2006). Source: Jiménez-Uzcátegui & Betancourt, 2005, 2006, 2007.

On the basis of these findings, the CDF, the Galapagos National Park (GNP), and the Environmental Protection Unit of the National Police have held workshops for local drivers, improved the system for controlling speed of vehicles, constructed speed control devices, etc., to reduce bird mortality. However, the data show that these efforts have not achieved the desired results.

## Recommendations

### Training

Organize workshops for drivers covering traffic laws and the problems that vehicles cause for the fauna, making passing the course a requirement for obtaining a driver's license.

### Maintenance and signage

- a. Place traffic signage on the highways: metallic and/or painted signals on the asphalt.
- b. Cut the vegetation to a distance of 1 m from the shoulder along the sides of the highway to improve visibility.

### Control

- a. Improve the regulations for vehicles entering and leaving the archipelago. This regulation is currently under revision.
- b. Intensify the control of vehicle speed, especially during the hot season.
- c. Apply norms for the use and control of vehicles as established in the Management Plan for the GNP, with respect to roads and transportation within the park zones.
- d. Identify public use vehicles with visible numbers on their exterior.

### Driving

- a. Use the horn when species are observed on the roadway.
- b. Respect traffic signals and laws.

### Future

- a. Install internal speed blocks in vehicles with a limit of 80 km/hour (except for ambulances, fire engines, and police).
- b. Implement an integrated and environmentally-friendly system for mass transportation (light rail or vehicular) over the long term, both in Baltra (Itabaca Canal to the airport) and in Santa Cruz (Puerto Ayora to Itabaca Canal).

### Conclusion

The principal cause of bird mortality along Galapagos highways is excessive speed of vehicles. Therefore all drivers must be conscious of the importance of obeying all traffic laws. Habitat fragmentation in the ecosystem resulting from the presence of highways has a significant impact on the native fauna populations of Santa Cruz. Currently we do not know the quantitative impact of vehicles on the fauna of the other islands. Therefore, it is recommended that similar studies be carried out in Isabela and San Cristóbal. The anthropogenic stress in the wild populations of native and endemic species is high, which can have a notable effect most especially on the species that are currently found on the Red List.